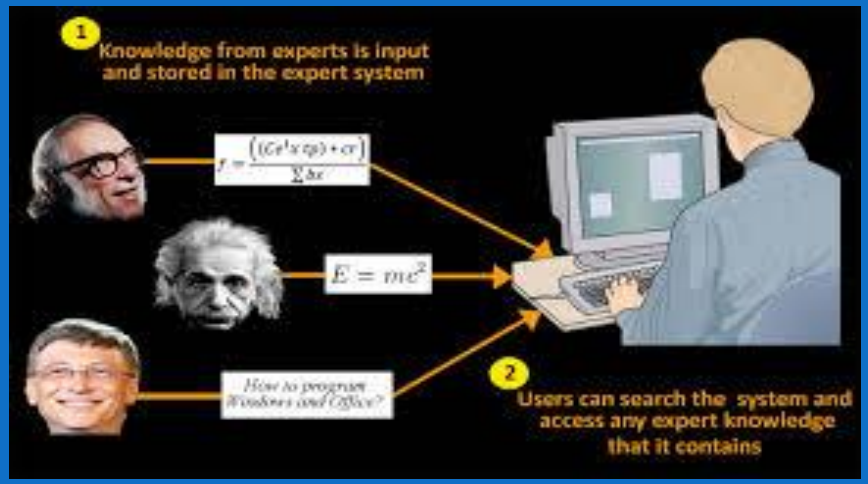
Artificial Intelligence
Expert Systems



Content

- What is an Expert System?
- Characteristics of an Expert System.
- Components of an Expert System.
- Advantages & Disadvantages of Expert Systems.
- Creating an Expert System.

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Expert System

- Computer software that:
 - Emulates human expert
 - Use human knowledge to solve problems that normally would require human intelligence
 - Deals with small, well defined domains of expertise
 - Is able to solve real-world problems
 - Is able to act as a cost-effective consultant
 - Can explains reasoning behind any solutions it finds
 - Should be able to learn from experience.

Expert System

- An expert system is a system that employs human knowledge captured in a computer to solve problems that ordinarily require human expertise.(Turban)
- A computer program that emulates the behaviour of human experts who are solving real-world problems associated with a particular domain of knowledge. (Pigford & Braur)

Expert System

- Expert Systems manipulate **knowledge** while conventional programs manipulate **data**.
- An expert system is often defined by its structure.
- Knowledge Based System Vs Expert System

- **ES Development**

Problem Definition.

System design…(*Knowledge Acquisition).*

Formalization. *(logical design,,,,, tree structures)*

System Implementation. *(building a prototype)*

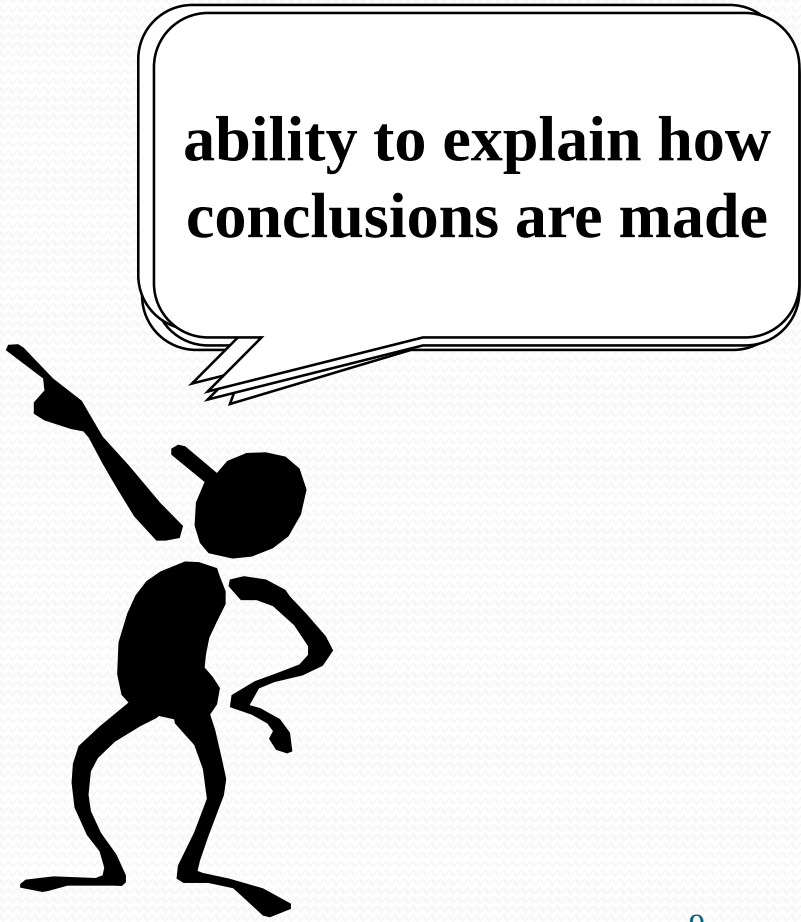
System Validation.

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Characteristics of an Expert System

- Expertise
- Depth
- Symbolic Reasoning
- Self Knowledge

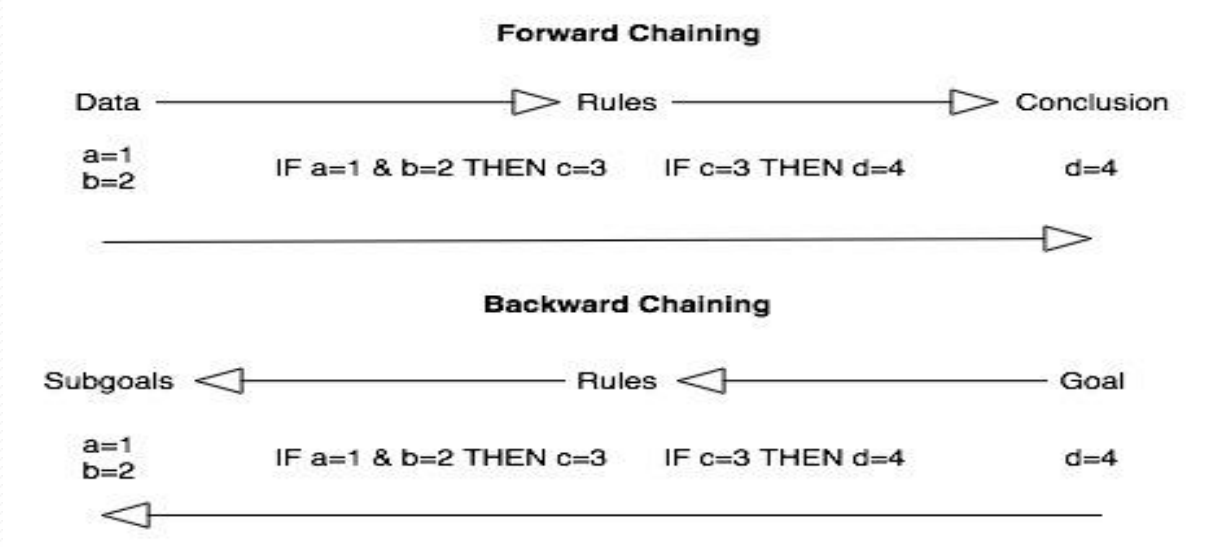


Characteristics of an Expert System

- Goal driven reasoning or backward chaining - an inference technique which uses IF THEN rules to repetitively break a goal into smaller sub-goals which are easier to prove
- Data driven reasoning or forward chaining - an inference technique which uses IF THEN rules to deduce a problem solution from initial data
- Uncertainty - the ability of the system to reason with rules and data which are not precisely known
- Data representation - the way in which the problem specific data in the system is stored and accessed
- User interface - that portion of the code which creates an easy way to use the system
- Explanations - the ability of the system to explain the reasoning process that it used to reach a recommendation.

Goal-Driven Reasoning

- **Aim**: to pick the best choice from many enumerated possibilities
- The knowledge is structured in rules
- The rule breaks the problem into sub-problems
- Difference between forward and backward chaining:



Goal-Driven Reasoning

- **Example** - This rules identifies birds:

 IF
 family is albatross and
 color is white

 THEN
 bird is Laysan albatross

 IF
 family is albatross and
 color is dark

 THEN
 bird is black footed albatross

- The following rule is one that satisfies the family sub-goal:

 IF
 order is tubenose and
 size large and
 wings long narrow

 THEN
 family is albatross

Data Driven Reasoning

- Problem of enumerating all of the possible answers before hand
- Example - configuration problems
- Keeps track of the current state, looks for rules moving the state closer to a final solution
- **Note:**
 - Data driven system: the system must be initially populated with data
 - Goal driven system: gathers data as it needs it

Data Driven Reasoning

- Example - A system to layout living room furniture (unplaced pieces of furniture):

 IF
 unplaced TV and
 sofa on wall(X) and
 wall(Y) opposite wall(X)

 THEN
 place TV on wall(Y).

Knowledge and Uncertainty

- Facts and rules are structured into a knowledge base and used by expert systems to draw conclusions.
- There is often a degree of uncertainty in the knowledge.
 - Things are not always true or false
 - the knowledge may not be complete.
- In an expert system certainty factors are one way indicate degree of certainty attached to a fact or rule.

Explanations

- Ability to explain themselves
- System knows which rules were used during the inference process
- At other times, relatively useless to the user
 - Example - car diagnostic system: no rules

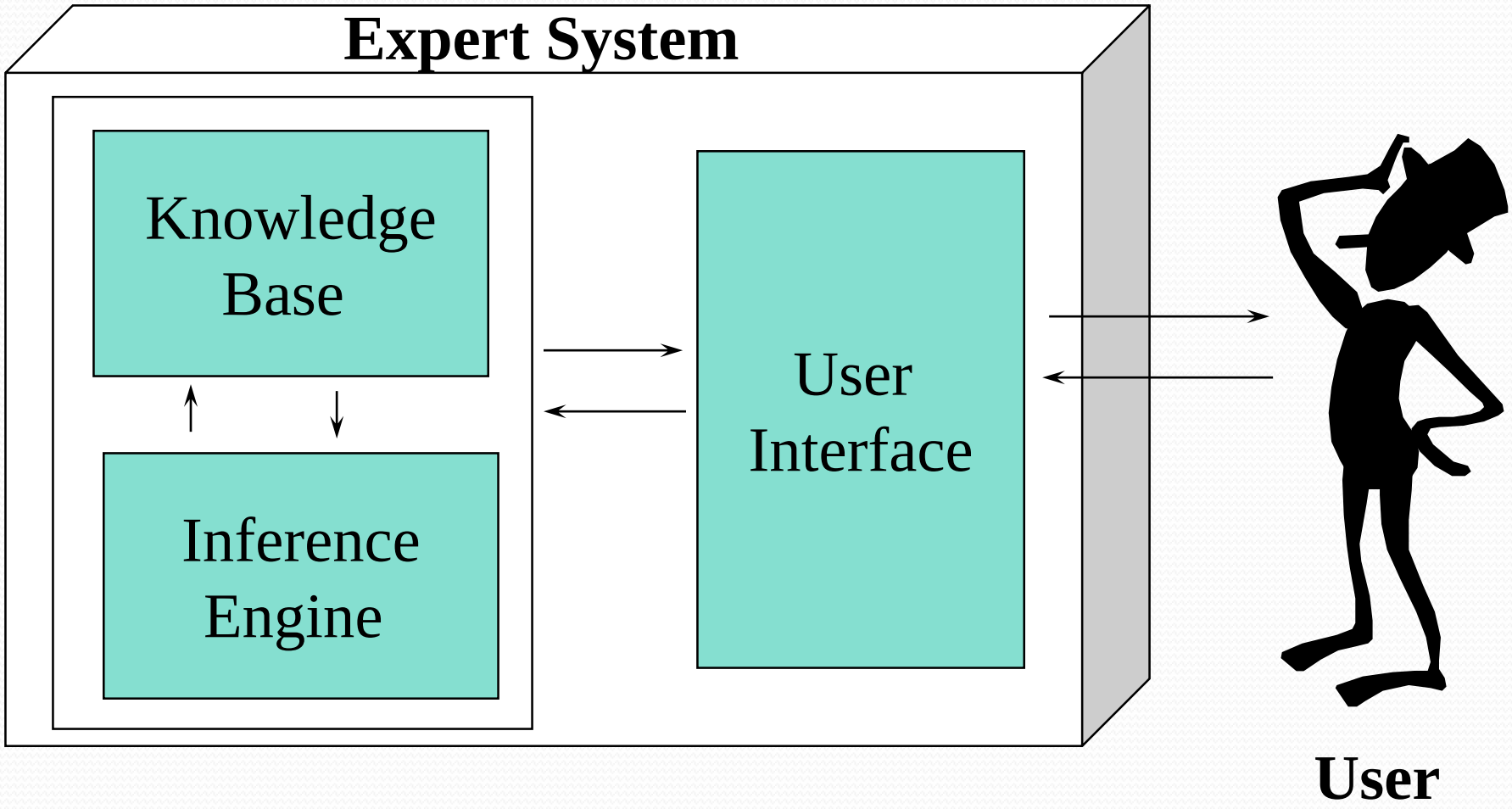
Desirable Features of an Expert System

- Dealing with Uncertainty
 - certainty factors
- Explanation
- Ease of Modification
- Transportability
- Adaptive learning

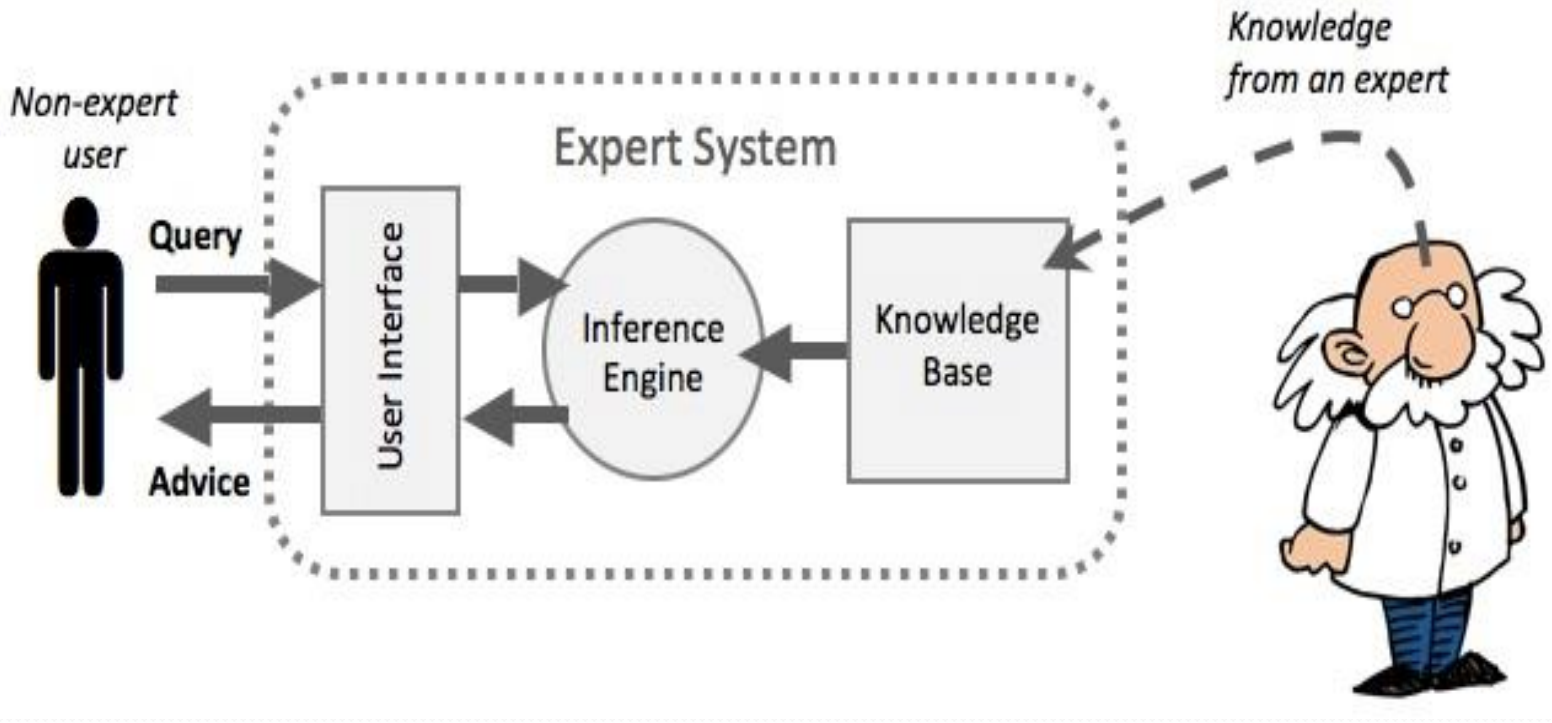
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Components of an Expert System



Components of an Expert System



Components of an Expert System

- The **knowledge base** is the collection of facts and rules which describe all the knowledge about the problem domain
- The **inference engine** is the part of the system that chooses which facts and rules to apply when trying to solve the user's query
- The **user interface** is the part of the system which takes in the user's query in a readable form and passes it to the inference engine. It then displays the results to the user.

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Advantages

- Experts are not always available. An expert system can be used anywhere, any time.
- Experts may not be good at explaining decisions
- Cost effective
- Superior problem solving
- Reliability: Human experts are not 100% reliable or consistent
- Work with incomplete information
- Transfer of knowledge

Limitations

- Expertise hard to extract from experts
 - don't know how
 - don't want to tell
 - all do it differently
- Knowledge not always readily available
- Difficult to independently validate expertise

Limitations (cont…)

- High development costs
- Can not learn from experience
- Not all problems are suitable
- Limited domain
- Systems are not always up to date, and don't learn
- No "common sense"
- Experts needed to setup and maintain system

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Creating an Expert System

- Two steps involved:

1. Extracting knowledge and methods from the expert (knowledge acquisition)
2. Reforming knowledge/methods into an organised form (knowledge representation)

Knowledge Acquisition

- Knowledge acquisition is the process by which knowledge available in the world is transformed and transferred into a representation that can be used by an expert system. World knowledge can come from many sources and be represented in many forms.

Knowledge Acquisition

- Manual:
 - interview with experts.
 - structured, semi structured, unstructured interviews.
 - track reasoning process and observing.
- Semi Automatic:
 - Use a computerised system to support and help experts and knowledge engineers.
- Automatic:
 - minimise the need for a knowledge engineer or expert.

Knowledge Acquisition Difficulties

- Knowledge is not easy to acquire or maintain
- More efficient and faster ways needed to acquire knowledge.
- System's performance dependant on level and quality of knowledge "in knowledge lies power."
- Transferring knowledge from one person to another is difficult. Even more difficult in AI. For these reasons:
 - expressing knowledge
 - The problems associated with transferring the knowledge to the form required by the knowledge base.
- collection should involve several sources not just one.
- experts change

Organizing the Knowledge

- Representing the knowledge
 - Rules
 - Semantic Networks
 - Frames
 - Propositional and Predicate Logic

Representing the Knowledge

- Rules

 If

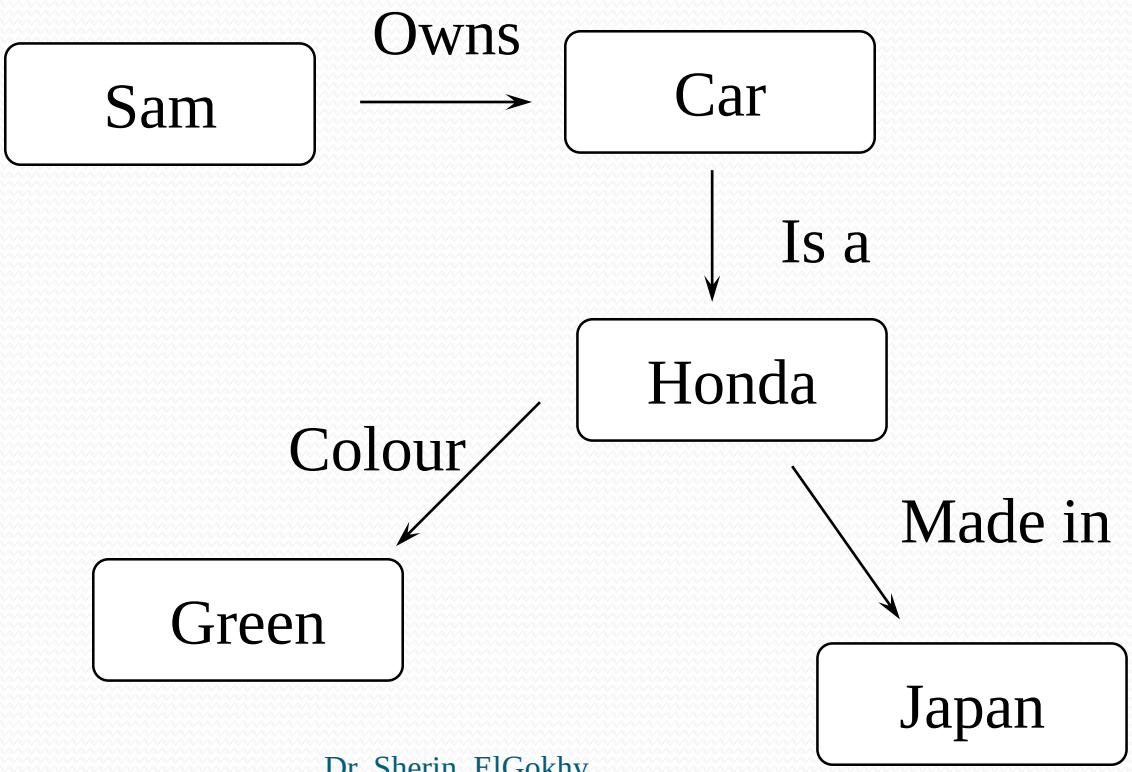
 pulse is absent and breathing is absent

 Then

 person is dead.

Representing the Knowledge

- Semantic Networks



Representing the Knowledge

- Frames
- based on objects
- objects are arranged in a hierarchical manner

Frame Name	Vacation
Where	Albury
When	March
Cost	$1000

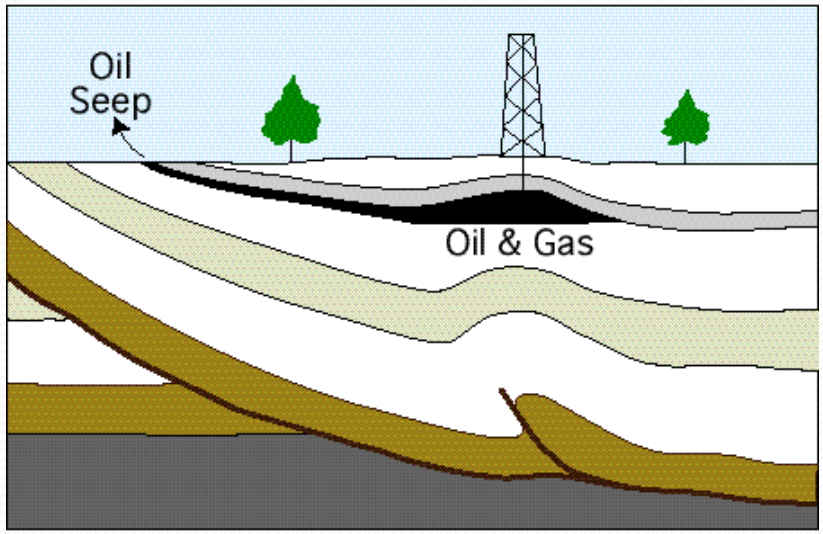
Representing the Knowledge

- Propositional & Predicate Logic
- based on calculus

- J = Passed assignment
 K = Passed exam
 Z = J and K
- Student has passed assignment and passes exam

Expert Systems Applications

Applications of Expert Systems

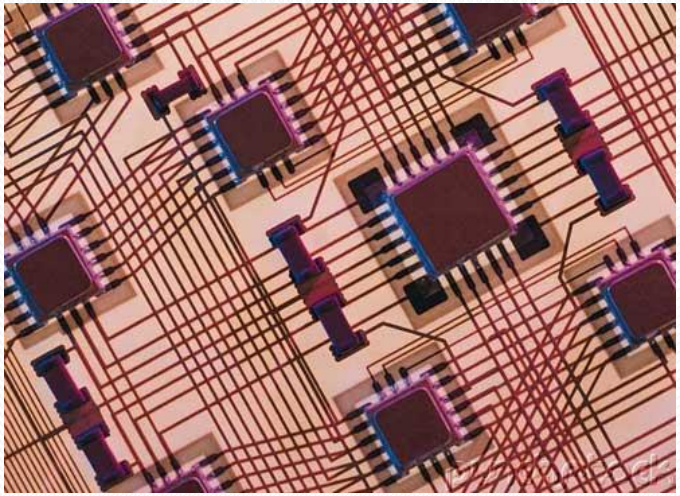


PUFF:
Medical system
for diagnosis of
respiratory conditions



PROSPECTOR:
Used by geologists
to identify sites for
drilling or mining

Applications of Expert Systems



DESIGN ADVISOR:
Gives advice to designers of processor chips

MYCIN:
Medical system for diagnosing blood disorders.
First used in 1979

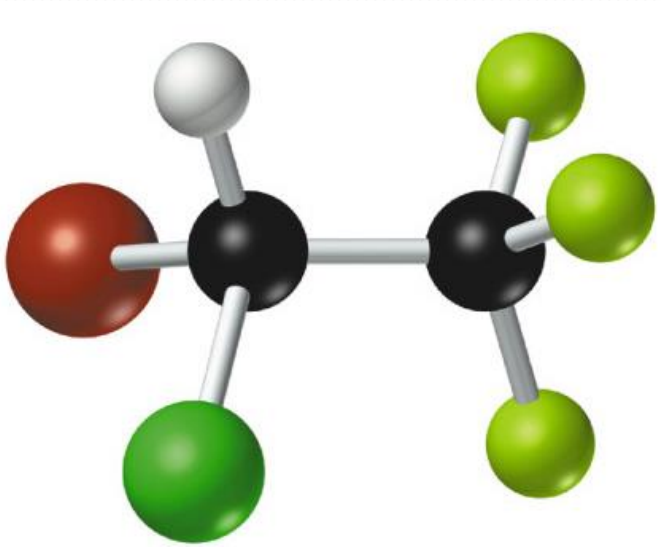


Applications of Expert Systems



LITHIAN: Gives advice to archaeologists examining stone tools

DENDRAL: Used to identify the structure of chemical compounds. First used in 1965



Expert Systems on the Web

- http://www.aiinc.ca/demos/whale.html
- http://www.vanguardsw.com/decisionscript/examples.htm
- http://www.exsys.com/demomain.html
- http://www.expertise2go.com/webesie/car
- http://www.expertise2go.com/webesie/wine

THANKS